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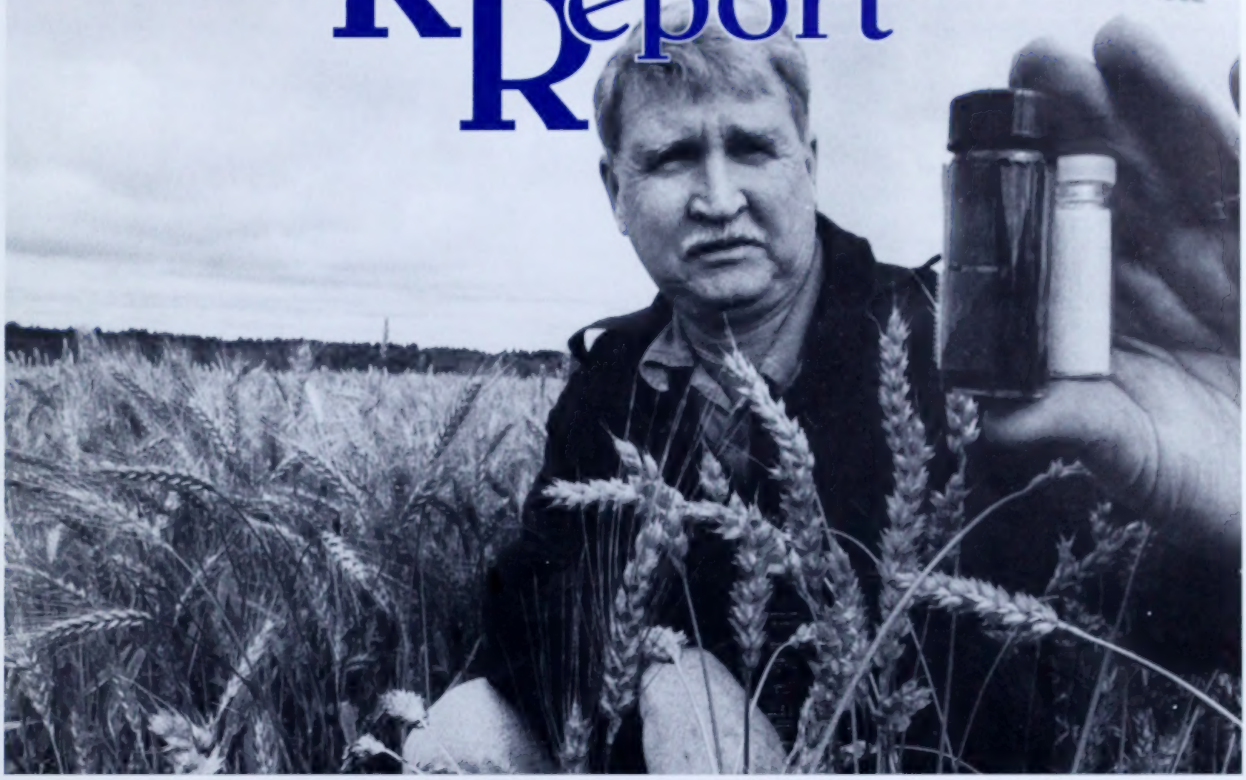

Researcher Doug Penney displays the two most effective types of copper fertilizer for wheat: liquid copper chelate (left) and copper sulphate.

The complexities of copper

Researchers are finding ways to fight yield-reducing copper deficiencies in central Alberta soils

"When we started our research in 1987, we didn't know if copper deficiency was a big problem in Alberta soils," says Doug Penney of Alberta Agriculture's Soils and Crop Management Branch. "At the time we knew some organic soils and possibly some sandy soils were deficient. Now we estimate about 3 million acres, including some of our better soils, are prone to copper deficiency. Often the copper levels in these soils are low enough to significantly reduce yields and quality of cereal crops."

Penney and three other researchers in the Soils and Crop Management Branch, Elston Solberg, Ieuan Evans and Denise Maurice, are tackling this complex problem with funding assistance from the Alberta Agricultural Research Institute's Farming for the Future and Matching Grants programs, and from Esso Chemicals Ltd., Cominco Fertilizer Ltd., and Sherritt Gordon Ltd. The researchers have established nine sites throughout central Alberta to answer such critical questions as: How much copper is enough? Which crops and varieties are most tolerant of copper deficiency? What is the best copper fertilizer treatment? How do herbicide applications affect crop response to copper deficiency?

Copper is one of at least 13 soil-derived nutrients essential for normal plant growth. It is called a "micronutrient" because plants need it in much smaller amounts than they need "macronutrients" like nitrogen, phosphorus, potassium and sulphur. Copper is important in chlorophyll production, protein synthesis and respiration. Although copper is essential for good growth, it's not always easy to know if a crop is getting enough copper.

The researchers started their work in response to results from a Farming for the Future project by Agriculture Canada scientist L.J. Piening in the mid-1980s and a strip trial established in 1986 by Wilf Cody who was the Stony Plain District Agriculturist. Piening noted that wheat grown on copper deficient soils was susceptible to a disease called head melanosis. Copper applications reduced the occurrence of the disease and dramatically increased wheat yields on his Lacombe study plots. For example, Park wheat had a yield increase of over 2,000%, Columbus a 500% increase, and Neepawa a 430% increase. Cody applied copper sulphate on a Black soil near Stony Plain after observing that the crop there exhibited symptoms like those he had seen in a copper trial on organic soils in the Westlock area.

Piening's site has a sandy loam soil with a copper level of 0.2 ppm (equal to 0.2 milligrams in a kilogram) which was considered to be the critical level for copper deficiency in cereals at that time. "That critical level appeared to be too low for Alberta soils," says Solberg. "About the time we were starting our investigations, some researchers

reported 0.4 ppm as the critical level for Saskatchewan soils. Our first site, near Stony Plain, responded very strongly to copper applications, but it tested at 0.6 to 0.8 ppm."

That site has a Black soil with a light loam texture, and is part of the Winterburn soil series. Since then, they have found that copper deficiency in Alberta tends to occur in Black soils ranging from loamy sands to light loams. Table 1 presents some of their results for crops grown on these soils with copper levels ranging from 0.3 to 0.7 ppm. Using the soil series they have identified as prone to copper deficiency, the researchers are working with Alberta Soil Survey to better define the extent of the problem.

One of their chief research objectives is to improve the diagnosis of copper deficiency and set more accurate critical levels so producers can calculate the costs and benefits of copper fertilizer applications. "Diagnosis is not a quick and easy thing," says Solberg. "There's no single critical level applicable to all soils." The researchers are developing a set of critical levels based on factors like soil type, levels of other nutrients, organic matter content and, at least for some Gray Wooded soils, subsoil copper content. "The usual test for copper assesses only the surface soil," says Solberg. "We're trying to follow up on this to make testing procedures more accurate."

Management can also be part of the copper deficiency problem. "Many of the good things you do to soils tend to make copper deficiency worse," says Penney. "For example, producers often apply manure to areas with poor yields. But this actually further reduces yields if the low yields are caused by copper deficiency. Copper is held tightly by organic matter; adding organic matter just ties up even more copper." Also, copper deficiency may make a crop sensitive to injury from some herbicides. Maurice says, "Our preliminary results indicate a complex interaction between herbicide applications and copper deficiency, but we need to do further studies to really explain what's happening."

Table 1. Cereal Yields With and Without Added Copper, Sandy and Light Loam Soils, 1988 to 1990

Crop	*Yield without Copper (bu/ac*)*	*Yield with Copper (bu/ac)*	*Percent Increase*
Park Wheat, Legal (1988)	9	27	200
Park Wheat, Legal (1989)	10	34	210
Park Wheat, Stony Plain (1988)	17	46	171
Condor Barley, Stony Plain (1990)	26	80	208
Virden Barley, Stony Plain (1990)	52	99	90
Waldern Oats, Millet (1990)	114	130	14

*bushels per acre

Detecting symptoms — like dead leaf tips, increased susceptibility to diseases including ergot and melanosis, delayed maturity, delayed heading, and shrivelled kernels — is another way to tell if copper deficiency is a problem. But it isn't foolproof. Evans explains, "Even if you find only patches of symptoms you can't assume the rest of the field is O.K. Crops growing on marginally deficient soils may have losses of 20% or more in grain yield without showing any symptoms."

The research team is testing copper fertilizer sources, methods of application, timing and rates of application to develop accurate recommendations. Their results show copper fertilizers can be an extremely cost-effective way to overcome copper deficiency. "Increases in wheat yields of 100 to 1,000% and in barley yields of 20 to 50% are common," notes Penney. And copper's positive effects can last a long time, possibly 10 years or more. The researchers' oldest plots are still responding to the copper applications made in 1987. Broadcast copper sulphate or a relatively high rate of soil-sprayed copper chelate appear to be the best fertilizer option.

The researchers are also identifying crops and varieties which are tolerant of copper deficiency. "In marginally deficient areas, a producer could choose canola, for example, as an alternative to wheat or barley which are the most sensitive crops," explains Evans. "But usually cereal crops are part of the producer's crop rotation so we're also searching for tolerant varieties. This is complicated by the fact that some varieties express copper deficiency with readily identifiable symptoms while others do not, even though yields are diminished by a similar amount." Unfortunately, they are not finding many tolerant varieties. "We have identified Duke barley as significantly more tolerant than other barleys. For the other cereal crops, however, all varieties are fairly sensitive. And even with Duke, it would be worthwhile to apply copper to improve yields and quality if there's a moderate to severe deficiency."

Penney cautions that copper deficiency should be correctly diagnosed before any action is taken. "Although we want to get away from the traditional view that Alberta doesn't have any copper deficiency problems, that doesn't mean copper problems are everywhere. We'd like producers to watch for the symptoms, especially in peaty soils or Black soils with a sandy or light loam texture. If they suspect a problem, they should have their soil tested. If they are still unsure, they should apply copper fertilizer on a test strip." The researchers have prepared a factsheet (Agdex 532-2) which is available from Alberta Agriculture.

Here comes the future!

The 1992 Farming for the Future Conference lets you walk on the leading edge

Research is essential for the long-term development of our agri-food industry. Alberta's scientists — some of the best in the world — are exploring the many avenues in crop and livestock production and agricultural processing, and making important and practical discoveries. Now you can learn about these exciting, new developments at the **1992 Farming for the Future Conference**, sponsored by the Alberta Agricultural Research Institute.

Agricultural producers, processors, researchers, extension personnel and the public are all welcome to attend this conference. It will be held at the Westerner Exposition in Red Deer, Alberta, on November 19, 1992. The conference will focus on research results that are contributing to agricultural diversification.

The conference will open with a morning plenary session introducing diversification in crops, livestock and agricultural processing. During the afternoon, scientists will present their state-of-the-art research in concurrent sessions on these three subject areas. The conference will also celebrate Alberta's agricultural diversity in a showcase of displays. This stimulating day will finish with a banquet at which Alberta Associate Minister of Agriculture Shirley McClellan will be the keynote banquet speaker.

Scheduled crop research seminars include such topics as marketing of grains, production of alternative crops like safflower, herbs and spices, and new products from oilseeds. In the livestock research session, planned presentations range from improving swine productivity to consumer preference in meat products to elk and bison as alternative livestock. The agricultural processing session is planned to encompass subjects ranging from food packaging techniques to the quality of saskatoon berry products to meat preservation for longer storage life and consumer satisfaction.

The Farming for the Future Conference is designed for people like you — people interested in positive changes in agriculture and progress towards a stronger and more dynamic agri-food industry.

Research information at your finger tips

AGRIS provides easy access to Alberta-based agricultural research

It's 2:00 a.m. You can't sleep. You're worried about blackleg in your canola crop. You'd like to know what researchers have discovered about blackleg control. What are you going to do? Call AGRIS!

AGRIS is the Agricultural Research Information System supported by the Alberta Agricultural Research Institute and Alberta Agriculture. "AGRIS offers a comprehensive listing of agricultural research in Alberta," explains system operator Kent Racher. "It allows you to locate information on recent research in just seconds and it's available 24 hours a day to anyone with a computer, telephone and modem [a device which permits a computer to communicate over a phone line]."

The system, originally named the Ag-Research BBS (Bulletin Board System), was introduced on an experimental basis in 1989. "We were already using a range of methods to communicate results from Alberta-based research — reports, newsletters, conferences," says Dr. Ralph Christian, Executive Director of the Alberta Agricultural Research Institute, "because we know easy access to scientific and technical information is essential to spur progress in agriculture. A computerized database looked like an excellent communication option as more and more people in agriculture have their own computers."

Kent Racher at the Agricultural Research Information System terminal.

AGRIS has come a long way since 1989. It started with about 500 project listings; it now has over 1,000. Usage has steadily increased to the present level of approximately 200 callers and 150 downloads per month. And its name has been changed to the Agricultural Research Information System to more accurately describe the services provided. Although it still functions as an electronic bulletin board — acting as a message centre and 'softwarehouse' — its main component is the agricultural research database.

Originally, the database listed only projects funded by the Farming for the Future Research Program, an Alberta Heritage Savings Trust Fund program started in the late 1970s. The database has been expanded to include projects from Farming for the Future's On-Farm Demonstration Program as well as projects funded through the Institute's Matching Grants and Research Coordination programs. And the database is continually growing. Recently, Alberta research projects listed in the Inventory of Canadian Agri-Food Research (ICAR) have been added to the database, and On-Farm Demonstration listings are currently being updated.

Each project abstract includes the project's title and objectives, the researchers' names and addresses, and, if available, a summary of the project's results. "The abstract provides an outline of the research project," Racher says, "and, because AGRIS gives the researchers' names and addresses, users can contact the researchers directly if they need in-depth information about the project."

Finding information on AGRIS is easy. If, for example, you would like to know about research on blackleg in canola, you simply enter the keywords "canola" and "blackleg" and in seconds you'll have access to the relevant abstracts. "Topics can

Take a walk along the leading edge! Attend the 1992 Farming for the Future Conference!

The conference fee is $35 per person; $30 for groups of two or more ***OR*** if the registration is received by October 30, 1992.

For more information, call the Research Division of Alberta Agriculture at 403-427-1956. To have your name added to the mailing list for the conference, complete the coupon below and return it to the Research Division.

Please send me further information on the **1992 Farming for the Future Conference.**

Last name: _____ **First name(s):** _____

Organization: _____

Address: _____

_____

City/Town: _____ **Province:** _____

Postal code: _____

Telephone no. (work): _____ **(home):** _____

Return this coupon to: Research Division, Alberta Agriculture, 7000 - 113 Street, Edmonton, Alberta, Canada T6H 5T6.

(Cut along this line or photocopy this coupon)

be instantly located by selecting appropriate keywords via the FILTER word search program," says Racher. "This is a very fast search program. The system breaks each project entry down into single words and stores each word with a number indicating which abstract it comes from. In just a few seconds FILTER can search through all the words in the database and find the keywords you've selected. It also allows you to enter up to 20 keywords at a time, so you can focus in on a precise topic. It's a very easy way to locate information. And you can copy the abstract to your system while you're looking at it on your screen."

Since the database was introduced, a number of help bulletins have been incorporated to improve user friendliness. Says Racher, "The bulletins explain how to use the system, what abstracts are available, communication protocols, how a modem works, what 'baud' means, and so on."

Several software packages have also been added to help novices with basic computer and modem operations, he notes. "For example, AGRIS has editing packages, basic accounting packages, communication packages to assist in using the modem, and a disk utilities program which compresses files so it takes less time to transmit them over the modem. These are all shareware programs and are free for callers to download. If users find the shareware useful, they may donate money to the writer of the program."

AGRIS's message board can bring the agricultural community closer together through idea-sharing. "With the message board, users are able to leave messages to other individuals or to all users. For example, if you're having problems with AGRIS, you can leave a message for me. Or if you want to advertise an agriculture-related event, you could leave a message about it for all users. Or perhaps you've found a better way to use a piece of farm equipment or a new farm business management software package and you'd like to let others know about it, then leave a message on the AGRIS message board. We also have a list of other bulletin boards in the Edmonton area if you want to communicate your messages to a wider audience."

There are no charges to use AGRIS (although long-distance charges apply if you're calling from outside the Edmonton area) and there are no mandatory upload/download ratios.

So let your fingers do the searching with AGRIS and discover what's happening in agricultural research in Alberta. "The system is user friendly," says Racher, "but if you need any help just call me at Alberta Agriculture's Research Division at 427-1956, or leave a message for me on AGRIS." AGRIS operates at 9600 baud, N, 8, 1, and is accessed with the dataline number (403)438-2209.

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The AARI's Vital Role Continues

by Dr. Ralph Christian

Executive Director Alberta Agricultural Research Institute

This spring marked an important event for the Alberta Agricultural Research Institute (AARI). Associate Agriculture Minister Shirley McClellan announced the renewal of Farming for the Future, one of the AARI's main research support programs. Farming for the Future was allocated $5 million through the Alberta Heritage Savings Trust Fund for 1992-93 to continue funding high priority, practical agri-food research.

Since Farming for the Future's inception in 1979, approximately $68 million has been invested in more than 1,600 research and demonstration projects. Their results include new crop varieties, improved animal disease control methods, new food processing techniques, and better marketing and economic information.

In April 1991, Farming for the Future's two funding vehicles — the Research Program and the On-Farm Demonstration Program — came under the auspices of the ARRI. This Crown corporation is Alberta's primary agency for agricultural research coordination and funding. Established by an Act of the Alberta Legislature in 1987, the AARI's goals are to coordinate, promote and support research in agriculture and to ensure the transfer of the resulting knowledge for the benefit of a viable and sustainable agri-food industry.

The Institute's other research support programs are the Matching Grants Program, the Research Coordination Program and the Research Professorship Program. Along with Farming for the Future, these programs form the main components of the AARI's multifaceted approach to advancing agri-food research and demonstration.

The Matching Grants Program stimulates private sector support for agricultural research by matching funds from industry for approved research projects. It also provides matching grants for joint projects with federal agencies and agencies of other provinces.

The Research Coordination Program is designed to enhance communication and cooperation among researchers. Funds are granted for activities which promote coordination, such as travel to annual research review and planning meetings, and inter-laboratory exchanges.

The Research Professorship Program provides funds to intensify research efforts in target disciplines at specific academic institutions. The program attracts talented scientists in areas of emerging importance to Alberta and facilitates the training of new scientists.

The Institute also administers funds from other agencies for specific research projects, and it manages Alberta's participation in the National Agricultural Biotechnology Initiative. This Initiative, jointly undertaken by the federal government and the four western provinces, assists the private sector in the commercialization of agricultural biotechnology products.

A Board of Directors appointed by the Associate Agriculture Minister conducts the Institute's affairs. The Board is chaired by Mr. Bob Bogle, MLA for Taber-Warner. The AARI's Act specifies that the Board must include at least nine agricultural producers or representatives of industries related to agriculture. As well, certain agencies must be represented on the Board: Alberta Agriculture; the Faculty of Agriculture and Forestry at the University of Alberta; Agriculture Canada; the University of Calgary; the Western College of Veterinary Medicine; Alberta Advanced Education; either Alberta Technology, Research and Telecommunications or the Alberta Research Council; and the Legislative Assembly of Alberta. The Board's broad representation promotes coordination and ensures that the various segments of the agri-food industry have input into the decision-making process. The Board has established six research committees, four strategic committees and six On-Farm Demonstration committees to advise it on policy, planning and technical matters.

Agricultural research is like a spark which ignites progress in our agri-food industry. It lights the way to more sustainable production, more cost-effective processing, more nutritious food, and more competitive products. Research supported by the AARI is helping Alberta's agricultural producers and processors to continue to develop a strong, vibrant industry.